

2024 ASCE Concrete Canoe Competition

CENE 476

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Project Information and Purpose:



Figure 1: Mark Lamer [1]

- Purpose: Develop a prototype for 100 future canoes.
- Competition: Participate in the April 2024 Intermountain Southwest (ISWS) conference.
- Client: Mark Lamer and American Society of Civil Engineers (ASCE).



Figure 2: Utah State Map [7]

Project Locations:

Northern Arizona University

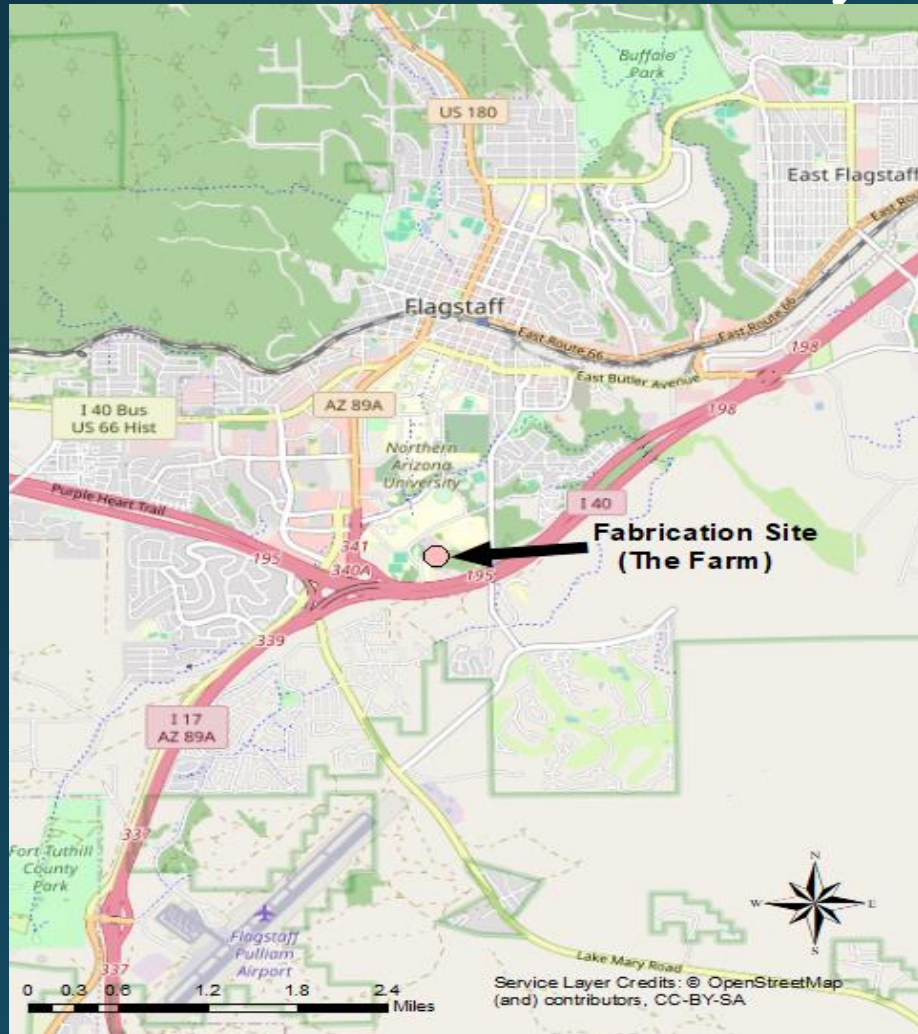


Figure 3: Northern Arizona University Location [7]

Utah State University

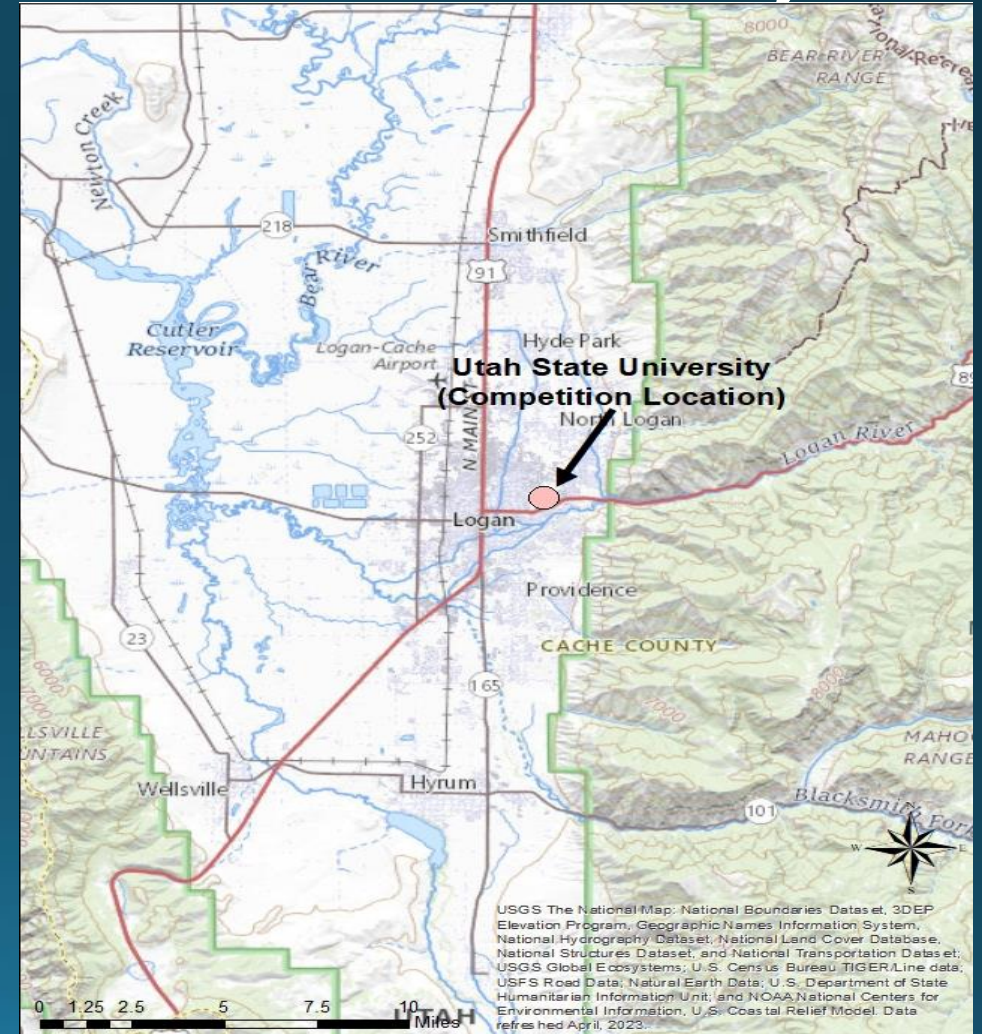


Figure 4: Utah State University Location [7]

Task 1: Project Scope of Services

- Task 1.1: Material Research
- Task 1.2: Competition Rules Research
- Task 1.3: NAU CE Lab Access
- Task 1.4: Software Training



Figure 5: Different types of aggregates & Fibers -
Courtesy of Jon Duran.

Task 2: Mix Design

- Task 2.1: Concrete Design Criteria
- Task 2.2: Aggregates Testing
 - Sieve analysis
 - Fineness modulus
- Task 2.3: Concrete Testing
 - Quality Control
 - Slump
 - Air density
 - Compression strength
 - Flexural and Tensile strength
 - Workability



Figure 6: Stacked sieves used for a gradation & size test.
-Courtesy of Jon Duran.



Figure 7: Concrete Cylinder for Compression Test.
-Courtesy of Jon Duran.

Task 3: Hull Design

- Task 3.1: Hull Design Criteria
- Task 3.2: Hull Modeling and Analysis
- Task 3.3: Analysis Alternative

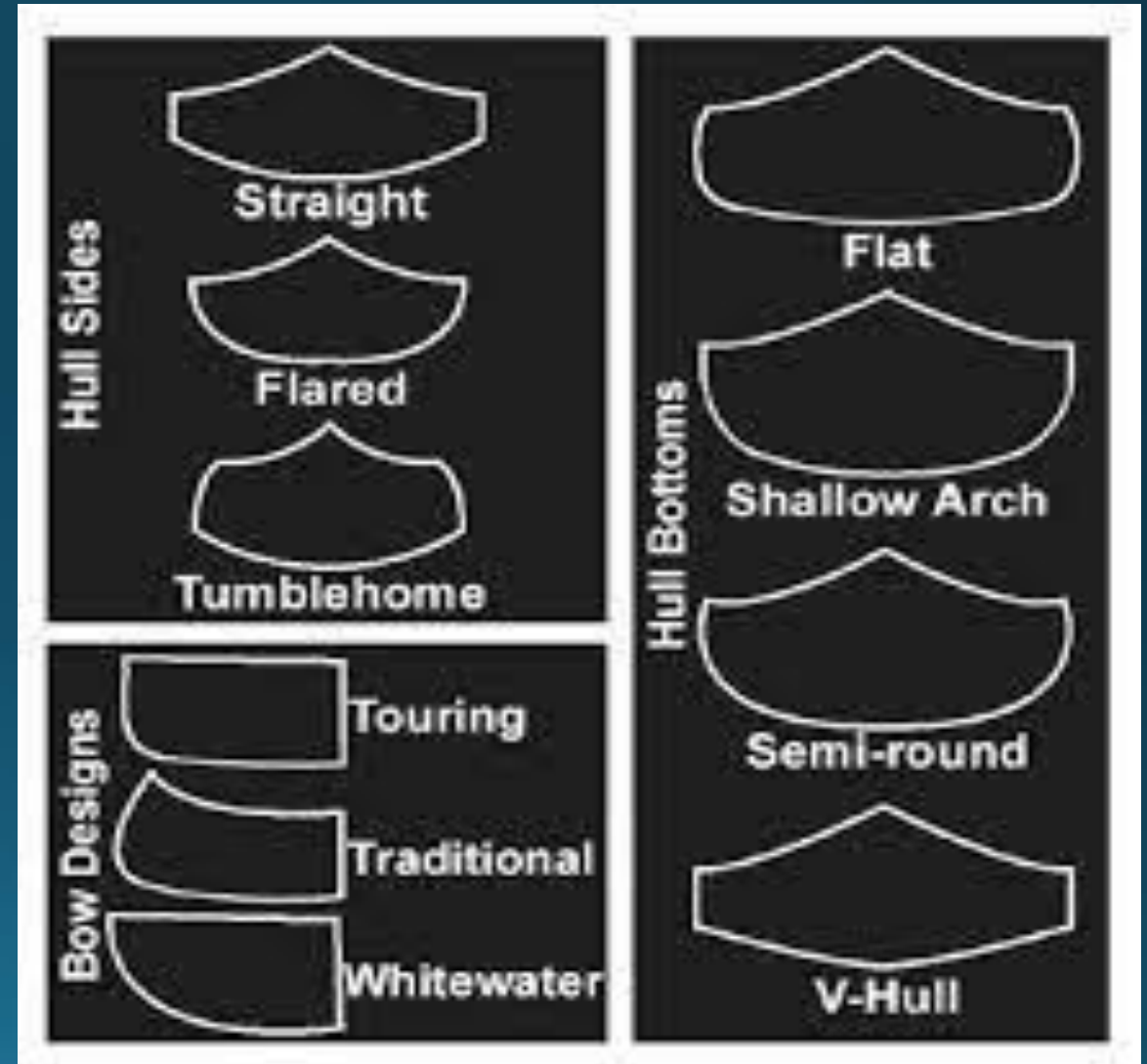


Figure 8: Canoe Hull Designs [2].

Task 4: Decision Matrix

➤ Task 4.1: Canoe Decision Matrix

- Includes 3 designs
- Scored on
 - Speed
 - Maneuverability
 - Buoyancy



Figure 9: Concrete cylinder break.
-Courtesy of Dylan Condra.

➤ Task 4.2: Concrete Decision Matrix

- Includes 3 designs
- Scored on
 - Compression strength
 - Flexural Strength
 - Tensile Strength
 - Workability
 - Renewables

Task 5: Analysis of final Design

➤ Task 5.1: 2D Analysis

- Longitudinal Analysis
- Punch Shear Analysis

➤ Task 5.2: 3D Analysis

- Principal Stress State Analysis
- Buoyancy Analysis

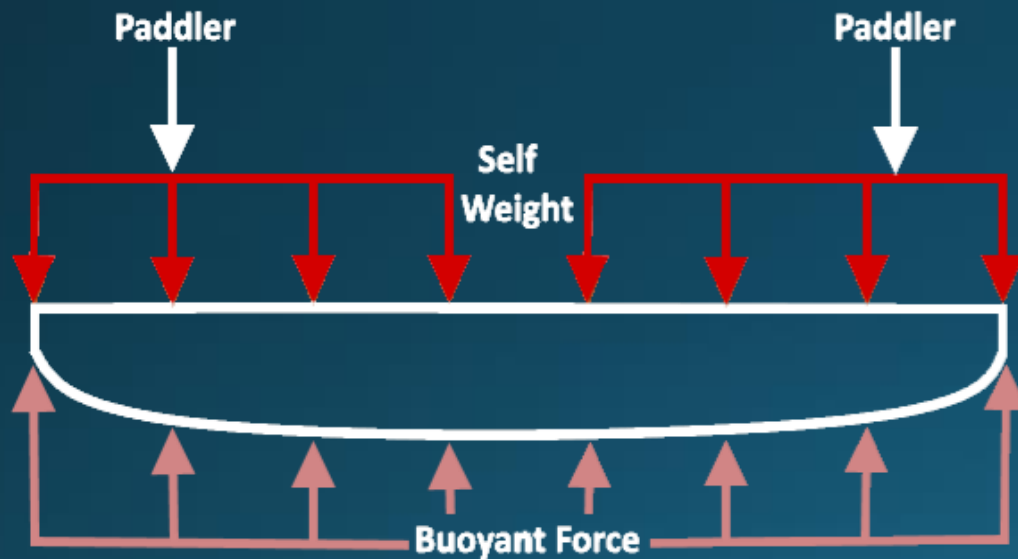


Figure 10: 2D Canoe Force Analysis.
-Courtesy of Kevin Tautimer.

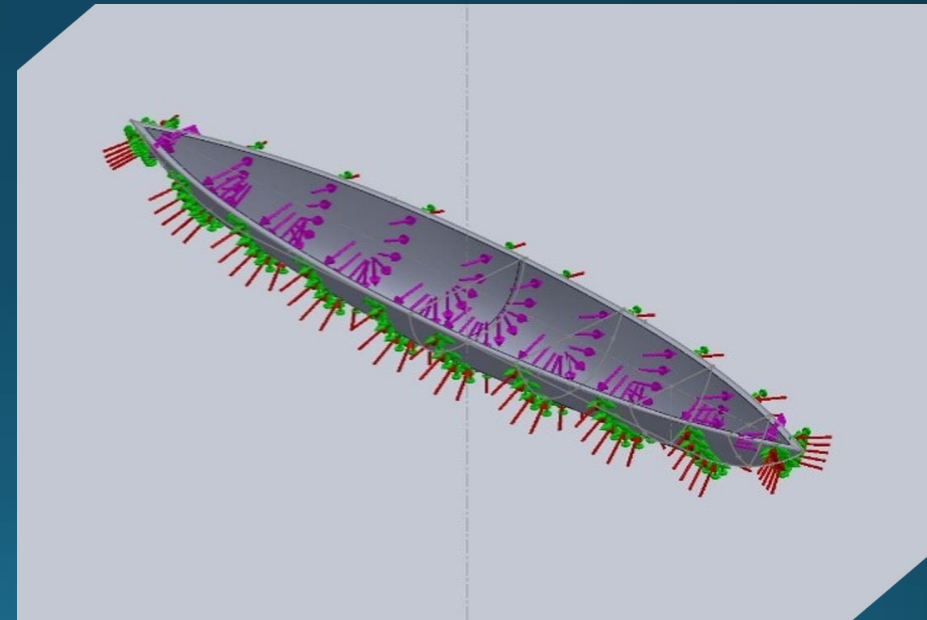


Figure 11: 3D Canoe Force Analysis.
-Courtesy of Derek Vecchia.

Task 6: Canoe Fabrication

- Task 6.1: Lab Approval and Compliance
- Task 6.2: Mold Acquisition
- Task 6.3: Shop Drawings of Final Hull Design
 - Plan view
 - Profile view
 - Section view



Figure 12: Section of Canoe mold.
-Courtesy of Jon Duran.



Figure 13: Multi-axis Router[4].

Task 7: Pre-competition Preparation

➤ Task 7.1: Race Practice



Figure 15: Canoe flipping [5].

➤ Task 7.2: Transportation



Figure 14: University of Indiana
Transporting Canoe [8].

Task 8: Deliverables

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- 30% Submittal (Tasks 1-3)
- 60% Submittal (Tasks 1-6)
- 90% Submittal (Tasks 1-10)
- Final Submittal

Competition

- Material Notebook
- Project Proposal
- Canoe Race
- Project Presentation
- Static Display

Task 9: Project Impacts

- Task 9.1: Environmental
- Task 9.2: Economical
- Task 9.3: Social

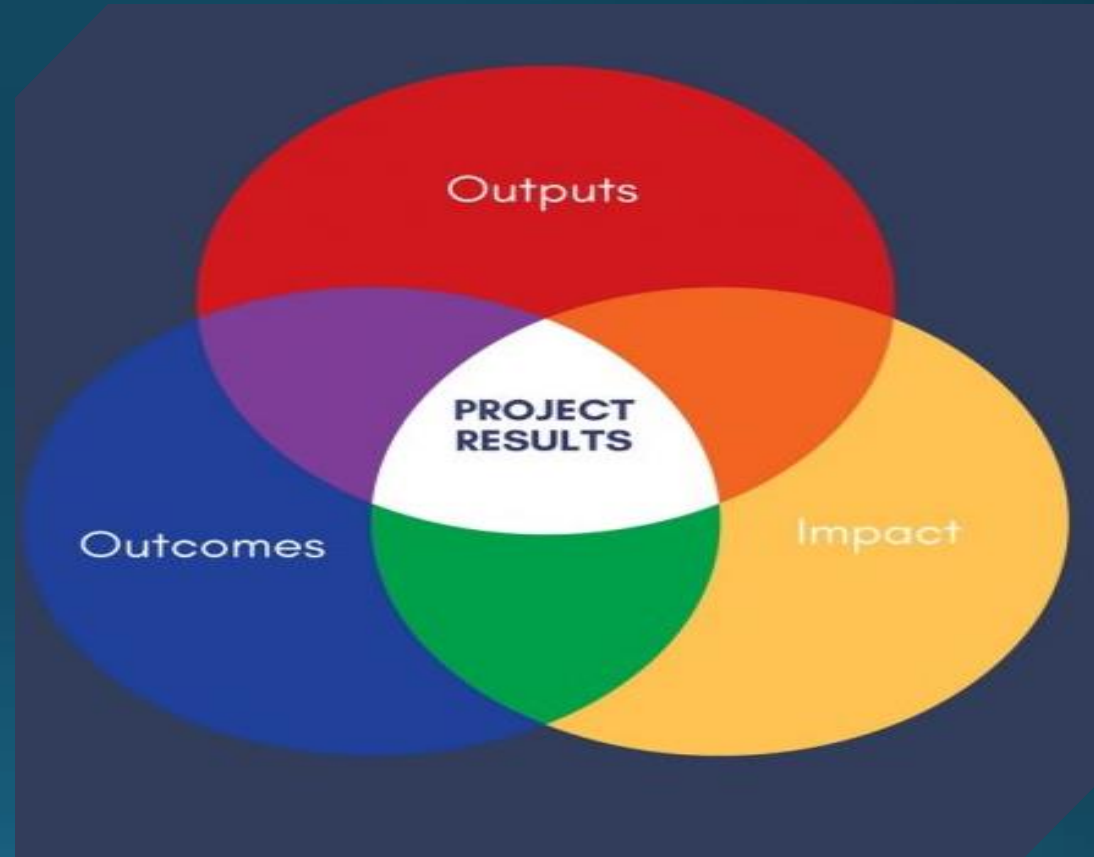


Figure 15: Project Impacts [6].

Task 10: Project Management

- Task 10.1: Meetings
 - Client Meetings
 - Grading Instructor Meetings
 - Technical Advisor Meetings
- Task 10.2: Resource Management
- Task 10.3: Schedule Management

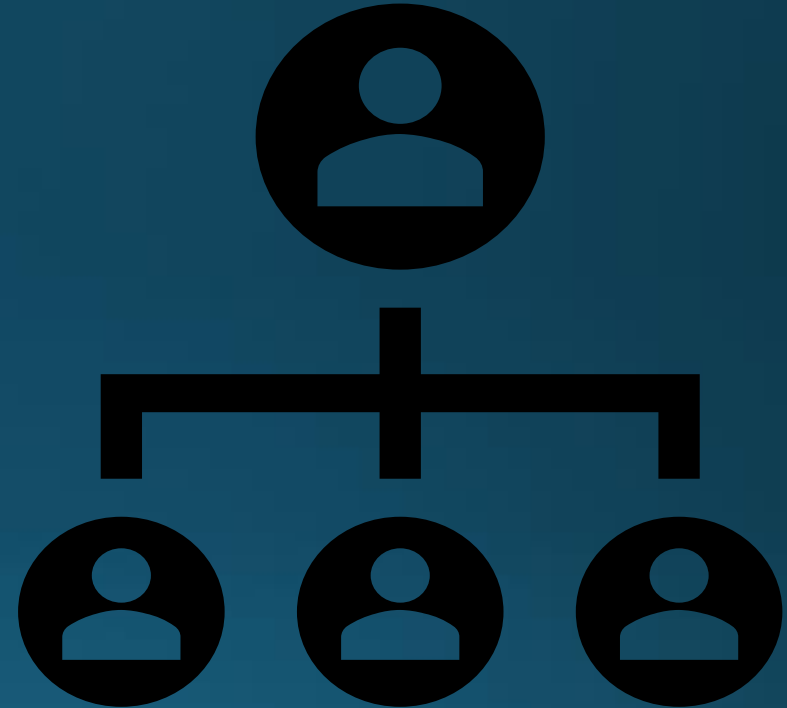


Figure 16 : Project Management Icon

Exclusions:

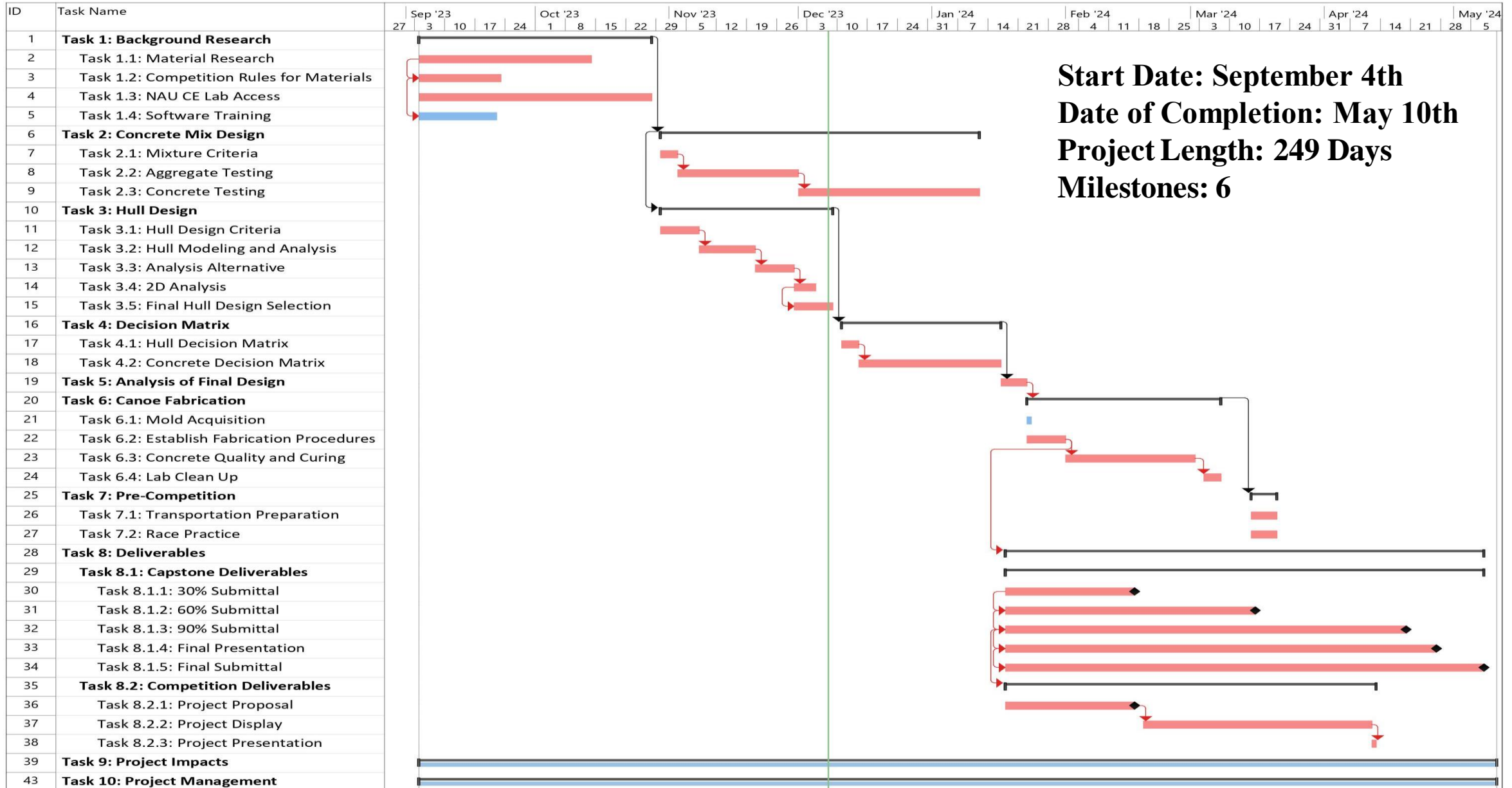
- ASCE Student Chapter Annual Report
- The construction of the 100 canoes

Staffing Positions:

- **Principle Design Engineer (PDE)** - Client's relationships, time management, hydrostatic and hydrodynamic concepts, concrete mix design, structural analysis, and finalizer
- **Technician/Drafter (TD)** - Hydrostatic and hydrodynamic concepts, codes, calculations, overseers, structural analysis
- **Quality Manager (QM)** - PPE procurement, material pickup, and ASTM testing
- **Project Construction Manager (PM)** - Safety laboratory protocols, safety agreement, and PPE procurement, and concrete mix design
- **Gradate Field Engineer (EIT)** - General duties reporting to ENG & TECH, including driving, material management, and racing

Table 1: Staffing base and Billing

Classification	Billing Rate \$/hr
Principal Design Engineer	\$120
Project Construction Manager	\$88
Quality Manager	\$87
Graduate Field Engineer	\$38
Technician/Drafter	\$62



Start Date: September 4th
Date of Completion: May 10th
Project Length: 249 Days
Milestones: 6

Project Staffing Hours:

Table 2: Staffing hours

Task Name	PDE Hours	PM Hours	TD Hours	EIT Hours	QM Hours
Task 1: Background Research	20	58	49	24	46
Task 1.1: Material Research	2	40	10	7	15
Task 1.2: Competition Rules	6	6	6	6	6
Task 1.3: NAU CE Lab Access	2	2	18	4	10
Task 1.4: Software Training	10	10	15	7	15
Task 2: Concrete Mixture Design	10	48	34	17	31
Task 2.1: Concrete Design Criteria	0	30	5	0	10
Task 2.2: Aggregate Testing	0	6	6	0	12
Task 2.3: Concrete Testing	0	0	5	2	5
Task 3: Hull Design	26	7	17	9	42
Task 3.1: Hull Design Criteria	2	2	2	2	2
Task 3.2: Hull Modeling and analysis	10	0	5	0	20
Task 3.3: Analysis Alternatives	14	5	10	7	20
Task 4: Decision Matrix	13	9	11	11	16
Task 4.1: Final Hull Design Selection	1	1	1	1	1
Task 4.2: Punch Shear Analysis	10	4	5	5	10
Task 4.3: Principal Stress State Analysis	2	4	5	5	5
Task 5: Analysis of Final Decision	4	9	15	22	30
Task 5.1: Structural Design Criteria and Analysis	2	5	5	10	10
Task 5.2: 3D Analysis	2	4	5	10	10
Task 5.3: 2D Analysis	0	0	5	2	10

Table 3: Staffing hours

Task Name	PDE Hours	PM Hours	TD Hours	EIT Hours	QM Hours
Task 6: Canoe Fabrication	20	16	16	28	28
Task 6.1: Lab Approval and Compliance	8	8	8	8	8
Task 6.2: Mold Acquisition	0	0	0	16	16
Task 6.3: Establish Fabrication Procedures	4	4	4	0	0
Task 7: Pre-Competition Preparation	8	4	4	4	4
Task 7.1: Transportation Preparation	4	0	0	0	0
Task 7.2: Race Practice	4	4	4	4	4
Task 8: Deliverables	40	40	40	40	40
Task 8.1: Capstone Deliverables	20	20	20	20	20
Task 8.2: ASCE Competition Deliverables	20	20	20	20	20
Task 9: Project Impact Analysis	6	6	6	6	6
Task 9.1: Social	2	2	2	2	2
Task 9.2: Economical	2	2	2	2	2
Task 9.3: Environmental	2	2	2	2	2
Task 10: Project Management	40	30	20	20	20
Task 10.1: Meetings	20	20	20	20	20
Task 10.2: Resource Management	20	10	0	0	0
Subtotal:	187	227	212	181	263
Total:					1070

Project Costs



Table 4: Total Cost Estimate

Engineering Services Cost Estimate					
Cost Type	Description	Quantity	Unit of Measure	Rate (USD)	Cost
Personnel					
	PDE	187	Hr.	\$120	\$17,880
	PM	227	Hr.	\$88	\$13,464
	TD	212	Hr.	\$62	\$8,742
	EIT	181	Hr.	\$87	\$12,006
	QM	263	Hr.	\$38	\$7,942
	Total Personnel				\$60,034
Travel					
Material Acquisition					
	Transportation	300	Miles	\$0.40	\$120
	Van Rental	3	Van/Day	50	150
Competition					
	Transportation	1,206	Miles	\$0.40	\$482
	Van Rental	1	Van/Week	\$340	\$340
	Hotel Rooms (3 rooms)	3	Nights	\$600	\$1,800
	Meals (5 People, 4 Days)	3	Meals/Day/Person	\$20.00	\$1,200
	Total Travel				\$4,092
Manufacturing					
Lab Access					
	Farm	10	Days	\$200	\$2,000
	Geotech Lab	10	Days	\$200	\$2,000
	Water/Concrete Lab	10	Days	\$200	\$2,000
Subcontracting					
	Mold Manufacturer	5	Days	\$200	\$1,000
	Western Tech	5	Days	\$200	\$1,000
Materials					
	Cement	10	Cubic Feet	\$8	\$80
	Aggregate	12	Cubic Feet	\$22	\$264
	Sand	0.05	Ton	\$10	\$1
	Admixtures	1	GAL	\$20	\$20
	Reinforcement	20	Square Yard	\$15	\$300
	Total Materials				\$8,665
Project Total					\$72,791

References

- [1] <https://www.ceias.nau.edu/capstone/projects/CENE/2020/SinclairWash/>. NAU, 2020.
- [2] 9/27, Hull Design Kickstart. New Jersey: The College of New Jersey, 2018.
- [3] *Mohr's Circle*. Prepineer, 2023.
- [4] Xycorp's, 2023.
- [5] A Stock Market “Tipping Point” Has Been Reached, According to Morgan Stanley. Business Insider, 2018.
- [6] A. Alonzi, Project Results. 2023.
- [7] “ArcGIS Streetmap USA.” ESRI, 2001.
- [8] Grainger Engineering Office of Marketing and Communications. “Illinois to Host 2013 National Concrete Canoe Competition.” *Civil & Environmental Engineering | UIUC*, cee.illinois.edu/news/illinois-host-2013-national-concrete-canoe-competition. Accessed 7 Dec. 2023.

The image features a dense field of 3D question marks. Most are dark grey and recede into the background, creating a sense of depth. In the center, one question mark is highlighted in a bright yellow color, standing out prominently. The word "Questions?" is written in a clean, white, sans-serif font, centered over the yellow question mark.

Questions?